COMMONWEALTH OF AUSTRALIA

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Chapter 5

Business Decisions Using Cost Behavior

Claudia June is the owner of Upstart T-Shirt Shop, one of many souvenir shops located on Highway A1A in Daytona Beach, Florida. Upstart sold 3,000 T-shirts during 1997 (the company's first year of operation), and Claudia's accountant prepared the following multistep income statement for the year.

UPSTART T-SHIRT SHOP
Income Statement
For the Year Ended December 31, 1997

Sales		$36,000
Cost of Goods Sold		21,600
Gross Profit		$14,400
Operating Expense:		
Selling Expense	$9,500	
Administrative Expense	7,900	(17,400)
Operating Loss		$(3,000)

Frankly, Claudia was quite pleased with the results for 1997 because she did not expect the store to be profitable in its first year. As Claudia planned for 1998, she figured she needed to increase sales by only 625 T-shirts to break even for the year. Her reasoning was based on the fact that each T-shirt cost $7.20 and sold for $12, resulting in $4.80 gross profit on each T-shirt ($12.00 − $7.20 = $4.80). If the shop sold 3,625 T-shirts, it would earn a gross profit of $17,400 (3,625 × $4.80), which would be exactly enough to cover the selling and administrative expenses of $17,400. If Claudia met her sales goal, the store would break even in only its second year of operation.

As luck would have it, Upstart T-Shirt Shop sold exactly 3,625 T-shirts during the year ended December 31, 1998. Each T-shirt sold for exactly $12 and cost the company exactly

$7.20. Confident that the shop had broken even for the year, Claudia excitedly opened the envelope from her accountant and found the following multistep income statement for 1998.

UPSTART T-SHIRT SHOP
Income Statement
For the Year Ended December 31, 1998

Sales		$43,500
Cost of Goods Sold		26,100
Gross Profit		$17,400
Operating Expense:		
Selling Expense	$10,438	
Administrative Expense	8,897	(19,335)
Operating Loss		$(1,935)

Claudia was disappointed and discouraged when she saw an operating loss of $1,935 for the year. She rechecked the arithmetic and her assumptions about what it would take to break even for 1998 and could not understand why the store had an operating loss.

Claudia may not understand what happened, but after having studied Chapter 4 and its discussion of cost behavior, you should understand the problem. Claudia failed to consider that some costs are affected by changes in activity level and others are not. In this chapter, we explore cost-volume-profit analysis and see how business people use an understanding of this analytical technique to predict financial performance effectively. ■

LEARNING OBJECTIVES

After completing your work on this chapter, you should be able to do the following:

1. Describe the differences between a functional income statement and a contribution income statement.
2. Determine per unit amounts for sales, variable cost, and the contribution margin.
3. Determine the contribution margin ratio and explain its importance as a management tool.
4. Prepare and analyze a contribution income statement for a merchandising firm.
5. Describe cost-volume-profit (CVP) analysis and explain its importance as a management tool.
6. Use CVP analysis to determine the amount of sales required to break even or to earn a targeted profit.
7. Use CVP to perform sensitivity analysis.

THE CONTRIBUTION INCOME STATEMENT

As discussed in Chapter 4, separating costs by means of cost behavior provides managers insight about forecasting cost at different levels of business activity. This valuable cost behavior information, however, is not presented in either the multi-step or the single-step income statement used for financial reporting. The traditional income statement prepared for external parties separates costs (expenses) as either product costs or period costs.

functional income statement An income statement that classifies cost by function (product cost and period cost).

contribution income statement An income statement that classifies cost by behavior (fixed cost and variable cost).

An income statement that separates product and period costs is called a **functional income statement.** Management accountants have developed a special income statement format for internal use that categorizes costs by behavior (fixed cost and variable cost) rather than by function (product cost and period cost). An income statement that classifies costs by behavior is a **contribution income statement.** Now, do not be alarmed, as this new format is no more complicated than the income statements you studied in earlier chapters. The main difference between the two is that the contribution income statements list variable costs first, followed by fixed costs. Note that the contribution income statement cannot be used for financial accounting information prepared for external decision makers; it is only used for internal decision-making purposes.

Purpose of the Contribution Income Statement

Let us return to the Upstart T-Shirt Shop example to see how a contribution income statement could have helped Claudia better predict the future profitability of her merchandising company. The two income statements presented for Upstart (1997 and 1998) were functional income statements. Upstart's 1997 functional income statement is reproduced as Exhibit 5–1.

Exhibit 5–1
Upstart's 1997 Functional Income Statement

UPSTART T-SHIRT SHOP
Functional Income Statement
For the Year Ended December 31, 1997

	Sales		$ 36,000
Product Cost →	Cost of Goods Sold		21,600
	Gross Profit		$ 14,400
	Operating Expense:		
Period Cost →	Selling Expense	$9,500	
Period Cost →	Administrative Expense	7,900	(17,400)
	Operating Loss		$ (3,000)

We see that the cost information in Exhibit 5–1 is separated into product cost (cost of goods sold) and period cost (selling expenses and administrative expenses). Next we will examine how Claudia can convert her functional income statement into a contribution income statement.

First, Claudia needs additional information about the cost behavior of the expenses in Upstart's 1997 functional income statement. On request, Claudia's accountant provides the following information:

Cost of goods sold	All variable
Selling expense	40% variable, so 60% must be fixed
Administrative expense	$6,300 Fixed, so $1,600 must be variable

Discussion Question

5–1. With the cost behavior information just presented, can you help Claudia determine how much her profit will change if she sells 5,000 shirts in 1999? (Remember to look at the 1998 income statement shown at the beginning of the chapter.)

Now that she has Upstart's cost behavior information, Claudia can prepare a contribution income statement for 1997. The contribution income statement lists sales first, as does the functional income statement, with variable costs listed next. These costs are subtracted from sales to arrive at the contribution margin. **Contribution margin** is defined as the amount remaining after all variable costs have been deducted from sales revenue. The contribution margin is an important piece of information for managers, because it tells them how much of their company's original sales dollars remain after deduction of variable costs. This remaining portion of the sales dollars contributes to fixed costs and, once fixed costs have been covered, to profit. The contribution margin, then, is the amount available to contribute to covering fixed costs and ultimately toward profits for the income statement period.

contribution margin The amount remaining after all variable costs have been deducted from sales revenue.

Upstart's 1997 contribution income statement (through the contribution margin) is presented as Exhibit 5–2.

Exhibit 5–2
Upstart's Partial 1997 Contribution Income Statement

UPSTART T-SHIRT SHOP
Partial Contribution Income Statement
For the Year Ended December 31, 1997

Sales		$36,000
Variable Cost:		
Cost of Goods Sold	$21,600	
Variable Selling Expense ($9,500 × 40%)	3,800	
Variable Administrative Expense ($7,900 – $6,300)	1,600	
Total Variable Cost		(27,000)
Contribution Margin (Sales Less Total Variable Cost)		$ 9,000

Finally, fixed costs are listed and subtracted from the contribution margin to arrive at operating income, as shown in Exhibit 5–3.

Like a functional income statement, the contribution income statement can be detailed or condensed depending on the needs of the information users. It can also be prepared showing the per unit costs and percentage of sales calculations. A condensed version of Upstart's 1997 contribution income statement, including per unit and percentage of sales figures, is presented as Exhibit 5–4.

Throughout the rest of the chapter we will use a condensed version of the contribution income statement.

Discussion Questions

5–2. Why is the gross margin found on the functional income statement different from the contribution margin found on the contribution income statement?

5–3. Why is the operating loss shown on Upstart's 1997 contribution income statement exactly the same as the operating loss shown on the company's 1997 functional income statement?

Looking at the per unit column in Exhibit 5–4, we note that the contribution margin per unit is $3. We calculate this by dividing the total contribution margin of $9,000 by the number of units sold—in this case 3,000 ($9,000 / 3,000 = $3). The $3 per unit contribution margin means that for every T-shirt sold, the sale generates $3 to contribute toward fixed costs. Then, once fixed costs have been covered, $3 per T-shirt sold contributes to profit. That is, if Upstart sells one more shirt for $12, then the $12 selling price less the $9 variable cost leaves $3. The contribution margin contributes toward fixed cost first, then to profits.

Exhibit 5–3
Upstart's Completed 1997 Contribution Income Statement

UPSTART T-SHIRT SHOP
Contribution Income Statement
For the Year Ended December 31, 1997

Sales		$36,000
Variable Cost:		
Cost of Goods Sold	$21,600	
Variable Selling Expense ($9,500 × 40%)	3,800	
Variable Administrative Expense ($7,900 – $6,300)	1,600	
Total Variable Cost		(27,000)
Contribution Margin (Sales Less Total Variable Cost)		$ 9,000
Fixed Cost:		
Fixed Selling Expense ($9,500 × 60%)	$ 5,700	
Fixed Administrative Expense	6,300	
Total Fixed Cost		(12,000)
Operating Loss		$ (3,000)

Exhibit 5–4
Upstart's Condensed 1997 Contribution Income Statement

UPSTART T-SHIRT SHOP
Contribution Income Statement
For the Year Ended December 31, 1997

	Total	Per Unit	Sales (%)
Sales in Units	3,000	1	
Sales	$36,000	$12.00	100
Variable Cost	(27,000)	(9.00)	(75)
Contribution Margin	$9,000	$ 3.00	25
Fixed Cost	(12,000)		
Operating Loss	$ (3,000)		

contribution margin ratio The contribution margin expressed as a percentage of sales.

Note in the percentage column of Exhibit 5–4 that the contribution margin is 25 percent of sales. When the contribution margin is expressed as a percentage of sales, it is called the **contribution margin ratio.**

The contribution margin ratio is calculated by dividing the total contribution margin by total sales, or by dividing the per unit contribution margin by per unit selling price, as follows:

$$\frac{\text{Total Contribution Margin}}{\text{Total Sales}} = \text{Contribution Margin Ratio}$$

or

$$\frac{\text{Per Unit Contribution Margin}}{\text{Per Unit Selling Price}} = \text{Contribution Margin Ratio}$$

In the case of Upstart T-Shirt Shop, the calculations are as follows:

$$\frac{\$9,000}{\$36,000} = 25\%$$

or

$$\frac{\$3}{\$12} = 25\%$$

The contribution margin ratio is the same whether it is computed using total figures or per unit figures, because the contribution margin is based on sales minus only variable costs. Thus, the variable costs and contribution margin change in direct proportion to sales. This proportional relationship holds true whether we are using per unit amounts or amounts in total.

In our example, the 25 percent contribution margin ratio means that, of each sales dollar, 25 percent (or 25 cents) is available to contribute toward fixed cost and then toward profit.

Discussion Question

5–4. If Upstart's sales increase by $20,000, and the contribution margin ratio is 25%, by how much will profits increase?

The contribution income statement is a wonderful management tool because it allows managers to see clearly the amounts of fixed and variable costs incurred by the company. Understanding which costs are variable and which are fixed is essential if managers are to reasonably predict future costs. More importantly, a solid understanding of the contribution income statement approach and the concept of the contribution margin and contribution margin ratio is the backbone of another important decision-making tool: cost-volume-profit analysis.

COST-VOLUME-PROFIT ANALYSIS

cost-volume-profit (CVP) analysis The analysis of the relationship between cost and volume and the effect of these relationships on profit.

As its name implies, **cost-volume-profit (CVP) analysis** is the analysis of the relationships between cost and volume (the level of sales), and the effect of those relationships on profit. In this section, we examine how managers can use CVP concepts to predict sales levels at which a firm will break even or attain target profits. CVP analysis is a useful tool for managers, business owners, and potential business

owners for determining the profit potential of a new company or the profit impact of changes in selling price, cost, or volume on current businesses.

Thousands of businesses are started every day. Unfortunately, most of them fail a short time later, and the people who start these businesses suffer significant financial and emotional hardship. Such hardships might be avoided if new business owners used CVP analysis to evaluate the potential profit of their business ventures. With CVP analysis, a new business owner can discover potential disaster before starting the business, thereby preserving savings that could be used more productively elsewhere.

Breakeven

breakeven Occurs when a company generates neither a profit nor a loss.

break-even point The sales required to achieve breakeven. This can be expressed either in sales dollars or in the number of units sold.

We begin our coverage of CVP analysis with a discussion of breakeven. **Breakeven** occurs when a company generates neither a profit nor a loss. The sales volume required to achieve breakeven is called the **break-even point.** Because most businesses exist to earn a profit, why would managers be interested in calculating a break-even point? In at least two situations this kind of information is valuable. First, the break-even point will show a company how far product sales can decline before the company will incur a loss. This information could provide the encouragement to continue in business, or may provide an early warning of impending business failure. Second, owners and managers may use break-even analysis when starting a business, just as Claudia did with the Upstart T-Shirt Shop. Recall that Upstart experienced a $3,000 operating loss in its first year of operation, but Claudia expected the loss because she understood most businesses are not profitable in their first year. Her break-even prediction for Upstart's second year, however, failed to allow for certain cost increases as sales increased.

With our understanding of cost behavior and the contribution income statement, we can predict the level of sales that Upstart will need to break even for the year.

Let us look again at the 1997 contribution income statement for Upstart T-Shirt Shop, reproduced in Exhibit 5–5.

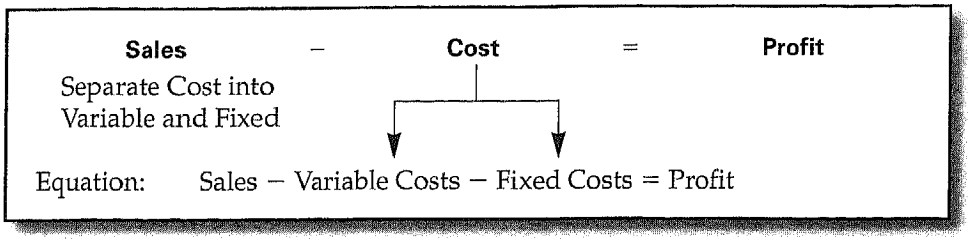
Exhibit 5–5
Upstart's Condensed 1997 Contribution Income Statement

UPSTART T-SHIRT SHOP
Contribution Income Statement
For the Year Ended December 31, 1997

	Total	Per Unit	Sales (%)
Sales in Units	3,000	1	
Sales	$36,000	$12.00	100
Variable Cost	(27,000)	(9.00)	(75)
Contribution Margin	$9,000	$ 3.00	25
Fixed Cost	(12,000)		
Operating Loss	$ (3,000)		

Managers who use CVP analysis must apply simple formulas to obtain useful information. Understanding and applying these formulas during this course should be relatively simple, but remembering them when you are actually working as a manager may be difficult. To make these formulas easier to remember, we will relate them to the most basic math used in an income statement, beginning with sales minus cost equals profit. Next, recall that cost can be broken down into variable and fixed cost. We use this information to derive a basic CVP equation, as shown in Exhibit 5–6.

Exhibit 5–6
Basic CVP Equation



The basic equation for CVP analysis in Exhibit 5–6 requires that the costs be identified as fixed or variable, and that any mixed cost be separated into its fixed and variable components. In the examples that follow, we assume costs have been properly classified as fixed or variable.

Managers can calculate the break-even point based either on units or on sales dollars. We will demonstrate the process in units first, and then in sales dollars.

Break-Even Point in Units To illustrate how to find the break-even point in units, we examine the Upstart T-Shirt Shop example. As shown in Exhibit 5–5, the selling price per T-shirt is $12, the variable cost is $9 per shirt, the contribution margin is $3 per T-shirt, and fixed costs total $12,000 per year. With this information, we can determine the number of T-shirts Upstart must sell to achieve a break-even point by dividing the contribution margin per unit into the total fixed cost, as shown in the following CVP formula:

CVP Formula 1—Break-Even Point in Units

$$\frac{\text{Total Fixed Cost}}{\text{Contribution Margin Per Unit}} = \text{Break-Even Point in Units}$$

Using the information from Upstart, we calculate the following:

$$\frac{\$12,000}{\$3} = 4,000 \text{ T-shirts}$$

By using this simple formula (and our knowledge of the cost behavior patterns associated with Upstart T-Shirt Shop), we see that if Upstart had sold exactly 4,000 T-shirts in 1998, the company would have broken even for the year. We can prove this fact if we use the equation from Exhibit 5–6 and the information from Upstart as follows:

Sales	–	Variable Costs	–	Fixed Costs	=	Profit
(4,000 × $12)	–	(4,000 × $9)	–	$12,000	=	Profit
$48,000	–	$36,000	–	$12,000	=	$ 0

We can also prove it by preparing a contribution income statement based on the results of our calculation, as shown in Exhibit 5–7.

Break-Even Point in Sales Dollars Because business performance is measured in total dollar sales and in the number of units of product sold, managers also find it useful to have breakeven presented in both sales dollars and unit sales. To demonstrate the calculation of the break-even point in sales dollars, we once again use the information provided by Upstart T-Shirt Shop's contribution income statement in Exhibit 5–5.

When calculating the break-even point in sales dollars, we divide the contribution margin ratio into total fixed cost, as shown in the second of the CVP formulas.

Exhibit 5–7
Upstart's Condensed 1998 Contribution Income Statement

UPSTART T-SHIRT SHOP
Projected Contribution Income Statement
For the Year Ended December 31, 1998

	Total	Per Unit	Sales (%)
Sales in Units	4,000	1	
Sales	$ 48,000	$12.00	100
Variable Cost	(36,000)	(9.00)	(75)
Contribution Margin	$ 12,000	$ 3.00	25
Fixed Cost	(12,000)		
Operating Income	$ -0-		

CVP Formula 2—Break-Even Point in Sales Dollars

$$\frac{\text{Total Fixed Cost}}{\text{Contribution Margin Ratio}} = \text{Break-Even Point in Sales Dollars}$$

Using the information from Upstart's contribution income statement, we know that total fixed cost is $12,000 and the contribution margin ratio is 25 percent. The break-even point calculation is

$$\frac{\$12,000}{25\%} = \$48,000 \text{ Sales Dollars}$$

A quick review of the contribution income statement in Exhibit 5–7 shows that our calculation of $48,000 sales at the break-even point is correct.

We have examined the calculation of a break-even point in required units and in sales dollars. As stated earlier, however, companies are not in business to break even. Rather, they are usually interested in earning profits. In the next section, we discuss how the break-even calculations are modified to predict a company's profitability.

Predicting Profits Using CVP Analysis

Claudia June now knows that her T-shirt business must sell 4,000 T-shirts to break even, assuming of course that the T-shirt selling price and the variable and fixed costs remain unchanged. Claudia can also use CVP analysis to predict Upstart's profit for any given level of sales above the break-even point. Assume, for example, that Upstart expects to sell 7,500 shirts in 1999. Claudia can quickly predict the expected profit at that sales level by preparing a contribution income statement, such as that in Exhibit 5–8.

Exhibit 5–8
Upstart's Condensed 1999 Projected Contribution Income Statement

UPSTART T-SHIRT SHOP
Projected Contribution Income Statement
For the Year Ended December 31, 1999

	Total	Per Unit	Sales (%)
Sales in Units	7,500	1	
Sales	$ 90,000	$12.00	100
Variable Cost	(67,500)	(9.00)	(75)
Contribution Margin	$ 22,500	$ 3.00	25
Fixed Cost	(12,000)		
Operating Income	$ 10,500		

If we did not want to take the time required to construct an actual contribution income statement, we could calculate the same operating income using the following basic CVP equation shown in Exhibit 5–6.

Sales	–	Variable Costs	–	Fixed Costs	=	Profit
(7,500 × $12)	–	(7,500 × $9)	–	$12,000	=	Profit
$90,000	–	$67,500	–	$12,000	=	$10,500

The sales figure in this calculation is the number of T-shirts multiplied by the selling price per unit (7,500 × $12 = $90,000). Variable cost is the number of T-shirts sold multiplied by the variable cost per unit (7,500 × $9 = $67,500). The fixed cost of $12,000 remains the same in total. With these three figures in place, simple arithmetic gave us the expected profit of $10,500 if 7,500 T-shirts are sold.

Projecting Sales Needed to Meet Target Profits Using CVP Analysis

Using CVP analysis to project profits at a given level of sales is only one application of this technique. Next we explore how to use CVP analysis when price and cost information are known, and a manager wants to determine the sales required to meet a specific target profit objective. As with the break-even point, we can apply CVP analysis to determine the sales needed to meet target profits in either units or sales dollars.

Projecting Required Sales in Units Assume Claudia targets $27,000 as Upstart's profit for 1999. By making a simple addition to the formula we used to calculate the break-even point, Claudia can determine how many T-shirts Upstart must sell to earn that target profit. The modified formula is as follows:

CVP Formula 3—Unit Sales Required to Achieve Target Profits

$$\frac{(\text{Total Fixed Cost} + \text{Target Profit})}{\text{Contribution Margin Per Unit}} = \text{Required Unit Sales}$$

Recall that the contribution margin is the amount available to contribute to covering fixed cost first, and then profits. When considering the break-even point, we calculated the number of units required simply to cover the fixed cost. In our present discussion, we are looking for the number of units required not only to cover the fixed cost, but also to achieve a specific target profit. As shown in CVP formula 3, we simply add the target profit to the total fixed cost and then divide the sum by the contribution margin per unit. This equation will tell us how many units must be sold to cover all the fixed cost and to attain the target profit. Using the information from Upstart, the calculation is as follows:

$$\frac{(\$12,000 + \$27,000)}{\$3} = \text{Required Unit Sales}$$

or

$$\frac{\$39,000}{3} = 13,000 \text{ T-Shirts}$$

We see, then, that with a fixed cost of $12,000 and a contribution margin per unit of $3, Upstart will need to sell 13,000 T-shirts to earn $27,000 profit.

Discussion Question

5–5. How would you prove to Claudia that 13,000 T-shirts must be sold to earn a $27,000 profit?

Projecting Required Sales in Dollars To demonstrate the calculation of the sales dollars required to attain target profits, we once again use the information provided by Upstart T-Shirt Shop's contribution income statement in Exhibit 5–5.

We use the contribution margin ratio as the denominator in the CVP formula, instead of the unit contribution margin, as follows:

CVP Formula 4—Sales Dollars Required to Achieve Target Profits

$$\frac{\text{(Total Fixed Cost + Target Profit)}}{\text{Contribution Margin Ratio}} = \text{Required Sales Dollars}$$

With the information from Upstart, the calculation is as follows:

$$\frac{(\$12,000 + \$27,000)}{25\%} = \text{Required Sales Dollars}$$

or

$$\frac{\$39,000}{25\%} = \$156,000 \text{ in Sales}$$

Discussion Question

5–6. How would you prove to Claudia that sales must total $156,000 to earn a $27,000 profit?

In this section we introduced you to four cost-volume-profit formulas, as summarized in Exhibit 5–9.

Exhibit 5–9
Cost-Volume-Profit Formulas

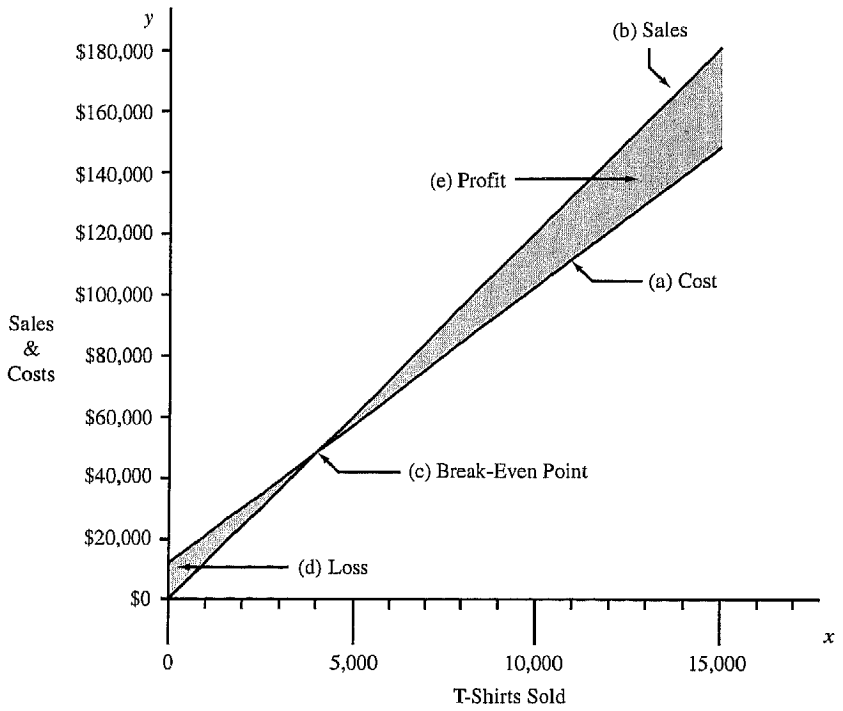
Formula	Calculation	Purpose
CVP Formula 1	$\frac{\text{Total Fixed Cost}}{\text{Contribution Margin Per Unit}}$	To determine the break-even point in units
CVP Formula 2	$\frac{\text{Total Fixed Cost}}{\text{Contribution Margin Ratio}}$	To determine the break-even point in sales dollars
CVP Formula 3	$\frac{\text{(Total Fixed Cost + Target Profit)}}{\text{Contribution Margin Per Unit}}$	To determine the unit sales required to achieve a target profit
CVP Formula 4	$\frac{\text{(Total Fixed Cost + Target Profit)}}{\text{Contribution Margin Ratio}}$	To determine the sales dollars required to achieve a target profit

These formulas are used daily by managers of manufacturing, merchandising, and service type companies as they attempt to predict the future performance of their firms. Regardless of the career you choose, if it involves business you will see these formulas again and will be using them much sooner than you might think.

Cost-Volume-Profit Graph

In addition to the calculations we have been studying, CVP analysis can also be depicted graphically. The graph used to present CVP analysis is similar to those used in the discussion of cost behavior in Chapter 4. A CVP graph for Upstart T-Shirt Shop is presented as Exhibit 5–10.

Exhibit 5–10
CVP Graph—Upstart T-Shirt Shop



The main difference between the graph in Exhibit 5–10 and those in Chapter 4 is the graph in Exhibit 5–10 shows sales in addition to variable and fixed costs. The cost line (a) on the graph is exactly like those in Chapter 4. Note that this line intercepts the *y*-axis at $12,000, the total fixed cost for Upstart T-Shirt Shop. Thus, Upstart incurs $12,000 fixed cost even if the company sells no T-shirts. The cost line slopes upward at $9 for each T-shirt sold (variable cost).

Now consider the sales line (b) on the graph. If Upstart sells no T-shirts, there would obviously be no sales dollars, which explains why the sales line intercepts the *y*-axis at zero. The line slopes upward at $12 for every T-shirt sold. The point at which the cost line and the sales line cross (c) is Upstart's break-even point, which we know from our calculations in this chapter to be 4,000 T-shirts, or $48,000 in sales revenue. The loss area (d) on the graph and the profit area (e) represent a loss and profit, respectively, for Upstart. Thus, if Upstart sells fewer than 4,000 T-shirts, the company will experience a loss. If it sells more than 4,000 T-shirts, the company will earn a profit.

Discussion Question

5-7. Using the CVP graph in Exhibit 5-10, can you plot the level of sales (in units and dollars) where Upstart will earn a profit of

a. $10,500?
b. $27,000?

The CVP graph is a useful management tool. Although it should not take the place of the calculations we have demonstrated thus far in this chapter, it has a distinct advantage over the calculations in that it allows managers to view the entire cost-volume-profit picture. Claudia June can, for example, assess Upstart's profit potential at any level of business within the relevant range of activity.

Discussion Question

5-8. If Claudia is faced with competition from a new T-shirt shop in town, and is forced to lower her selling price to $11 per T-shirt, how much profit can she expect in 1998? (Assume that Claudia expects to sell 13,000 shirts and the cost information stays the same.)

To demonstrate the basics of CVP analysis, we have assumed that the selling price per unit, variable costs per unit, and total fixed cost all remained unchanged. Businesses, however, experience daily pressures that can cause each of these items to change. CVP analysis can adapt to any such change.

Now that we have covered the basics, we are ready to put CVP to perhaps its greatest use: sensitivity analysis.

Sensitivity Analysis—What If?

sensitivity analysis A technique used to determine the effect on cost-volume-profit when changes are made in the selling price, cost structure (variable and/or fixed), and volume used in the CVP calculations. Also called "what if" analysis.

Sensitivity analysis is a technique used to determine the effect on CVP when changes are made in the selling price, cost structure (variable and/or fixed), and volume used in the calculations. Sensitivity analysis is also called "what if?" analysis. Managers are often looking for answers to the following types of questions, in terms of the effect on projected profits: "What if we raised (or lowered) the selling price per unit?" "What if variable cost per unit increased (or decreased)?" and "What if fixed cost increased (or decreased)?" Sensitivity analysis can provide those answers.

One other item to note before we proceed with the discussion of sensitivity analysis is that we will be using only CVP formula 3 and CVP formula 4. Although sensitivity analysis can certainly be used to assess the effect of changes in selling price, variable cost, and fixed cost on breakeven, all our examples will include target profits.

To demonstrate how sensitivity analysis is used, we return to Claudia June and the Upstart T-Shirt Shop. Assume 1999 has now ended. Upstart's contribution income statement for the year is presented as Exhibit 5-11.

Exhibit 5–11
Upstart's Condensed 1999 Contribution Income Statement

UPSTART T-SHIRT SHOP
Contribution Income Statement
For the Year Ended December 31, 1999

	Total	Per Unit	Sales (%)
Sales in Units	11,286	1	
Sales	$135,432	$12.00	100
Variable Cost	(101,574)	(9.00)	(75)
Contribution Margin	$ 33,858	$ 3.00	25
Fixed Cost	(12,000)		
Operating Income	$ 21,858		

Claudia is quite pleased with the $21,858 profit Upstart earned in 1999 and is aiming for a target profit of $27,000 in 2000 (the same target profit as 1999). The problem is that a new T-shirt shop just opened three doors from Upstart. Claudia feels she must lower her selling price to $11 due to competitive pressure and wants to know how many T-shirts Upstart must now sell to attain the $27,000 target profit. Claudia can use CVP analysis to determine the required sales level to achieve a targeted profit even if she changes her selling price.

Change in Selling Price

If the selling price changes but variable cost does not, the number of units required to attain a target profit is determined using CVP formula 3 and a recalculated contribution margin based on the new selling price. In the case of Upstart T-Shirt Shop, the new contribution margin is $2 (new selling price of $11 − variable cost of $9). We now apply this contribution margin to the formula. (Remember, the fixed cost is unchanged.)

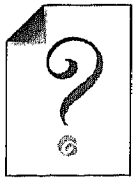
$$\frac{(\$12,000 + \$27,000)}{\$2} = \text{Required Unit Sales}$$

or

$$\frac{\$39,000}{\$2} = 19,500 \text{ T-shirts}$$

Our calculations show that with a lower selling price, as reflected in the revised contribution margin per unit, Upstart must sell 19,500 T-shirts to attain the target profit of $27,000.

Discussion Question



5–9. How would you prove to Claudia that 19,500 T-shirts must be sold to earn a $27,000 profit if she reduces the selling price per T-shirt from $12 to $11?

We can also calculate the sales dollars required to attain the target profit of $27,000. To do this, we first calculate a new contribution margin ratio and then use CVP formula 4 to determine the sales dollars needed to earn the target profit. The new contribution margin ratio is 18.182 percent (rounded), which is calculated by

dividing the new selling price ($11) into the new contribution margin ($2). We now apply this new information to CVP formula 4.

$$\frac{(\$12,000 + \$27,000)}{18.182\% \text{ (rounded)}} = \text{Required Sales Dollars}$$

or

$$\frac{\$39,000}{18.182\% \text{ (rounded)}} = \$214,498 \text{ Sales Dollars (rounded)}$$

By applying the revised contribution margin ratio to CVP formula 4, we see that Upstart will need $214,498 in sales to achieve the target profit of $27,000.

Discussion Questions

5-10. How would you prove to Claudia that sales must total $214,498 to earn a $27,000 profit if she reduces the selling price per T-shirt from $12 to $11?

5-11. Why must we calculate a new contribution margin ratio when the per unit selling price changes?

5-12. Under what other circumstances must we calculate a new contribution margin ratio?

If Claudia reduces her selling price to $11, then Upstart must sell 19,500 T-shirts in 2000 to earn the target profit of $27,000. Claudia believes it would be impossible to sell that many shirts, so she begins to consider alternative ways to earn a $27,000 profit in a competitive environment.

Notice that Claudia was able to determine by CVP analysis that her business may be in trouble. The analysis itself, however, does nothing whatever to solve the problem—that is up to Claudia. Management accounting can provide the informational tools to help managers and business owners spot problems, but it is ultimately up to the manager or owner to make the decisions and solve the problems.

Discussion Question

5-13. If Claudia must lower her selling price to $11 per shirt to be competitive, and it would be impossible to sell 19,500 T-shirts, what are some of the alternatives she might consider to attain the $27,000 profit?

Change in Variable Cost and Fixed Cost

Alternatives to changing the selling price include changing variable cost or fixed cost. Because Claudia believes the selling price per T-shirt must be $11, either the variable cost per unit or the total fixed cost must be reduced. We start with an analysis of possible changes in variable cost.

First, we must analyze how Upstart determined its original variable cost. We determine per unit variable cost by dividing the total variable cost by the number of units sold. Recall from the earlier discussion and Exhibit 5–4 that Upstart sold 3,000 T-shirts during 1997, and total variable cost was $27,000. Therefore, the variable cost per unit was calculated as $9 ($27,000 variable cost / 3,000 units sold).

Exhibit 5–12
Analysis of Upstart's Variable Cost Components

	Total Cost		Units Sold		Unit Cost	
Cost of Goods Sold (T-shirts)	$21,600	÷	3,000	=	$7.20	
Variable Selling Expenses	3,800	÷	3,000	=	1.27	
Variable Administrative Expenses	1,600	÷	3,000	=	.53	
Variable Cost	$27,000	Total			$9.00	Per Unit

To analyze how a change in variable cost will affect the variable cost per unit of $9, we must look at the three components of per unit variable cost: the cost of each T-shirt, the variable selling expenses, and the variable administrative expenses. We need to know what portion of the $9 variable unit cost relates to each component. We can determine these portions by dividing the 3,000 units sold into each of the three cost components. We use 3,000 because that number of units caused these costs to be incurred. We find the cost of each variable cost component in the contribution income statement presented in Exhibit 5–3. The cost and per unit calculation for each component are presented in Exhibit 5–12.

Claudia does not believe any change can be made in either the variable selling expenses or the variable administrative expenses. Any possible reduction in variable cost, then, must be in the cost of the T-shirts. Our calculations in Exhibit 5–12 show that the per unit cost of each T-shirt is $7.20.

Assume Claudia has contacted her shirt supplier which has agreed to lower its price from $7.20 to $6 per T-shirt. This reduction of $1.20 ($7.20 − $6.00 = $1.20) will reduce Upstart's variable cost from $9 per shirt to $7.80 per shirt ($9.00 − $1.20 = $7.80). The new contribution margin is $3.20 ($11 selling price − $7.80 variable cost = $3.20), and the new contribution margin ratio is 29.091 percent ($3.20 contribution margin / $11 selling price = 0.29091 or 29.091 percent rounded).

Now consider a change in Upstart's fixed cost. Recall that Upstart's total fixed cost is $12,000. Assume that Claudia has agreed to provide fellow businesswoman Susan Williams with space in her shop to sell bathing suits to Claudia's customers. Susan has agreed to pay Claudia $250 per month as rent on the space she will use. The $250 per month works out to be $3,000 per year ($250 per month × 12 months = $3,000). Thus, Upstart's total fixed cost decreases from $12,000 to $9,000.

With these proposed changes in Upstart T-Shirt Shop's variable cost and fixed cost, we can now do sensitivity analysis. Let us see what effect these changes would have on Claudia's company. To do this, again, we will use CVP formulas 3 and 4. We simply need to plug the new cost structures (variable and fixed) into the formulas as follows:

CVP Formula 3—Unit Sales Required to Achieve Target Profits

$$\frac{(\text{Total Fixed Cost} + \text{Target Profit})}{\text{Contribution Margin Per Unit}} = \text{Required Unit Sales}$$

$$\frac{(\$9,000 + \$27,000)}{\$3.20} = 11,250 \text{ T-shirts}$$

By using CVP formula 3 (and Upstart's new variable and fixed cost structure), we found that if Upstart sells 11,250 T-shirts in 2000, the company will earn a profit of $27,000.

To calculate the sales dollars required to attain Upstart's target profit of $27,000, we use the company's new contribution ratio and CVP formula 4:

CVP Formula 4—Sales Dollars Required to Achieve Target Profits

$$\frac{\text{(Total Fixed Cost + Target Profit)}}{\text{Contribution Margin Ratio}} = \text{Required Sales Dollars}$$

$$\frac{(\$9,000 + \$27,000)}{29.091\% \text{ (rounded)}} = \$123,750 \text{ in Sales (rounded)}$$

With the changes in cost structure Claudia has negotiated, she will be able to earn $27,000 profit in 2000 even if her sales drop from 11,286 T-shirts (the 1999 sales level) to 11,250 T-shirts.

Discussion Questions

5-14. How would you prove to Claudia that sales must total $123,750 (11,250 T-shirts) to earn a $27,000 profit if she reduces the cost per T-shirt from $7.20 to $6 and reduces total fixed cost from $12,000 to $9,000?

5-15. If Claudia is more successful than anticipated in 2000 and sells 13,000 T-shirts by reducing her selling price to $11, and she also implements the variable and fixed cost changes described earlier, what will be Upstart's profits for 2000?

5-16. What complications do you foresee in using CVP analysis if Claudia begins selling a deluxe line of T-shirts that cost $11.50 each and sell for $17?

Multiple Products and CVP

In reality, most companies sell more than one product. Companies that sell multiple products often have information about total variable cost and total sales for a given income statement period, but have no one variable cost and selling price that can be easily determined and used for CVP.

When a company sells multiple products, managers may still use CVP analysis, but they must apply CVP formula 2 for break-even analysis and CVP formula 4 to determine the required level of sales to attain target profits. CVP formulas 1 and 3 are useless in a multiproduct situation if the various products sold have different unit contribution margins.

To demonstrate how managers use CVP analysis in a multiproduct situation when per unit information is unavailable, let us consider the example of Margaret's Frame Factory.

Margaret's Frame Factory makes and sells picture frames of various size and quality. Exhibit 5–13 presents Margaret's condensed contribution income statement for 1997.

There is a per unit variable cost and selling price for each of the frame models Margaret's manufactures and sells, but they are not included in Exhibit 5–13. All we have are the totals. The $185,000 contribution margin comes from the sale of several different products, each with its own contribution margin. The 37 percent contribution margin ratio, then, is an average contribution margin ratio based on the sales mix of these different products. Even with this limited information, however, we can use CVP analysis to both calculate a break-even point and predict target profits.

APPLY WHAT YOU HAVE LEARNED

LO 4: Prepare a Contribution Income Statement

5–18. Fresh Baked Cookie Company sells cookies in a large shopping mall. The following multistep income statement was prepared for the year ending December 31, 2000.

FRESH BAKED COOKIE COMPANY
Income Statement
For the Year Ended December 31, 2000

Sales		$36,000
Cost of Goods Sold		4,000
Gross Profit		$32,000
Operating Expense:		
Selling Expense	$18,000	
Administrative Expense	10,000	28,000
Operating Income		$ 4,000

Cost of goods sold is a variable cost. Selling expense is 20% variable and 80% fixed, and administrative expense is 5% variable and 95% fixed.

REQUIRED:
Prepare a contribution income statement for the Fresh Baked Cookie Company.

LO 4: Prepare a Contribution Income Statement

5–19. The following multistep income statement was prepared for Steinmann's Bait Shop for the year ending December 31, 2000.

STEINMANN'S BAIT SHOP
Income Statement
For the Year Ended December 31, 2000

Sales		$98,000
Cost of Goods Sold		22,000
Gross Profit		$76,000
Operating Expense:		
Selling Expense	$27,000	
Administrative Expense	36,000	63,000
Operating Income		$13,000

Cost of goods sold is a variable cost. Selling expense is 30% variable and 70% fixed, and administrative expense is 10% variable and 90% fixed.

REQUIRED:
Prepare a contribution income statement for Steinmann's Bait Shop.

LO 4: Prepare a Contribution Income Statement

5–20. Quality Fishing Gear Company sells high-quality fiberglass fishing rods to retailers. The following multistep income statement was prepared for the year ending December 31, 2000.

REQUIRED:
Prepare a contribution income statement for the year ended December 31, 2000.

LO 4: Prepare a Contribution Income Statement

5–31. The following information is available for Nicole's Toy Manufacturing Company for 2000:

	Amount	Percent Fixed	Percent Variable
Direct material	$440,000	-	100
Direct labor	90,000	-	100
Variable manufacturing overhead	70,000	-	100
Fixed manufacturing overhead	800,000	100	-
Selling cost	950,000	45	55
Administrative cost	570,000	85	15

Sales for 2000 totaled $3,164,000 and there were no beginning or ending inventories.

REQUIRED:
Prepare a contribution income statement for the year ended December 31, 2000.

LO 4: Prepare a Contribution Income Statement

5–32. The following information is available for Rick's Watch Company for 2000:

	Amount	Percent Fixed	Percent Variable
Direct material	$534,000	-	100
Direct labor	129,000	-	100
Variable manufacturing overhead	397,000	-	100
Fixed manufacturing overhead	998,000	100	-
Selling cost	196,000	33	67
Administrative cost	243,000	78	22

Sales for 2000 totaled $2,745,000 and there were no beginning or ending inventories.

REQUIRED:
Prepare a contribution income statement for the year ended December 31, 2000.

LO 4: Prepare a Contribution Income Statement

5–33. Alumacraft Manufacturing makes aluminum serving carts for use in commercial jetliners. During 2001, the following costs were incurred:

	Amount	Percent Fixed	Percent Variable
Direct material	$2,600,000	-	100
Direct labor	1,820,000	-	100
Variable manufacturing overhead	540,000	-	100
Fixed manufacturing overhead	1,900,000	100	-
Selling cost	380,000	15	85
Administrative cost	230,000	5	95

Sales for 2001 totaled $7,900,000 and there were no beginning or ending inventories.

REQUIRED:
Prepare a contribution income statement for the year ended December 31, 2001.

LO 6: Determine Breakeven and Sales Required to Earn Target Profit Using Per Unit Amounts

5–34. The following information is available for Medical Testing Corporation.

Amount charged for each test performed	$ 90
Annual fixed cost	200,000
Variable cost per test	25

REQUIRED:
a. Calculate how many tests Medical Testing Corporation must perform each year to break even.
b. Calculate how many tests Medical Testing Corporation must perform each year to earn a profit of $25,000.

LO 6: Determine Breakeven and Sales Required to Earn Target Profit Using Per Unit Amounts

5–35. The following information is available for Dottie's Donut Shop.

Amount charged per dozen doughnuts	$ 0.99
Annual fixed cost	385,000.00
Variable cost per dozen doughnuts	0.22

REQUIRED:
a. Calculate how many dozen doughnuts Dottie must sell each year to break even.
b. Calculate how many dozen doughnuts Dottie must sell each year to earn a profit of $35,000.

LO 6: Determine Breakeven and Sales Required to Earn Target Profit Using Per Unit Amounts

5–36. Jim is considering starting a small company to paint driveways. The following information is available.

Amount charged per square yard painted	$ 5
Annual fixed cost	3,000
Variable cost per square yard painted	2

REQUIRED:
a. Calculate how many square yards of driveway Jim must paint each year to break even.
b. Calculate how many square yards of driveway Jim must paint each year to earn a profit of $5,000.

LO 6: Determine Breakeven and Sales Required to Earn Target Profit Using Per Unit Amounts

5–37. Carbonnel Calendar Company is considering adding a new calendar design to their line. The following information is available.

Selling price	$ 3.97
Additional annual fixed cost	4,558.00
Variable cost per calendar	3.11

Revenue	$3,650,000
Variable cost	1,387,000

REQUIRED:

a. Based on this information, what is the required revenue for the second store to break even?
b. Based on this information, what is the required revenue for the second store to earn a profit of $125,000?

LO 2, 4, & 6: Use Per Unit Amounts to Determine Breakeven and Sales Required to Earn Target Profit and Prepare a Contribution Income Statement

5–41. Richard Davenport owns a clothing store and is considering renting a soda vending machine for his store. He can rent the soda machine for $125 per month. Richard would supply the soda for the machine which he can buy for $3 per twelve pack. Richard plans to charge $0.75 per can.

REQUIRED:

a. List the fixed costs for renting and stocking the soda machine.
b. List the variable costs for renting and stocking the soda machine.
c. Calculate the contribution margin per can of soda.
d. (1) Calculate how many cans of soda Richard must sell each month to break even.
   (2) Prepare a contribution income statement that proves the answer you just calculated.
e. (1) Calculate how many cans of soda Richard must sell each month to earn a profit of $50.
   (2) Prepare a contribution income statement that proves your answer to the previous requirement.

LO 2, 4, & 6: Use Per Unit Amounts to Determine Breakeven and Sales Required to Earn Target Profit and Prepare a Contribution Income Statement

5–42. Erich Traebeecke owns the Kenpo Karate School in Miami. He is considering renting a candy vending machine for his school lobby. He can rent the candy machine for $90 per month. Erich would supply the candy bars for the machine. He can buy a box of eight candy bars for $1 per box. Erich plans to sell each candy bar for $0.35.

REQUIRED:

a. List the fixed costs of renting and stocking the candy machine.
b. List the variable costs of renting and stocking the candy machine.
c. Calculate the contribution margin per candy bar.
d. (1) Calculate how many candy bars must be sold each month to break even.
   (2) Prepare a contribution income statement that proves the answer you just calculated.
e. (1) Calculate how many candy bars must be sold each month to earn a profit of $180.
   (2) Prepare a contribution income statement that proves your answer to the previous requirement.